Tenth Annual Community Climate System Model Workshop, June 21-23, 2005, Breckinridge, CO. Poster: A model-observation comparison of intraseasonal wind-evaporation feedback during EPIC2001 and beyond

Maloney, E. D., and S. K. Esbensen, 2005: An observational study of east Pacific intraseasonal variability during boreal summer. *Eos Trans. AGU, 86(52)*, Fall Meet. Suppl., Abstract A53B-02. *(AGU 2005 Fall Meeting)*

Major findings from the first 10 months of the project are summarized below.

b. Maloney and Esbensen (2005)

We analyzed eastern north Pacific intraseasonal variability during June-September of 2000-2003 using satellite and buoy observations. QuikSCAT ocean vector winds and TRMM precipitation indicate that periods of anomalous surface westerly flow over the east Pacific warm pool during an intraseasonal oscillation (ISO) lifecycle are associated with an enhancement of convection (Figure 1a). A notable exception includes a narrow east-west band of suppressed convection that is centered near 8^{o}N to the south of the strongest wind anomalies. Widespread suppressed convection also occurs to the west of 120^{o}W during the westerly phase. Periods of surface easterly anom-

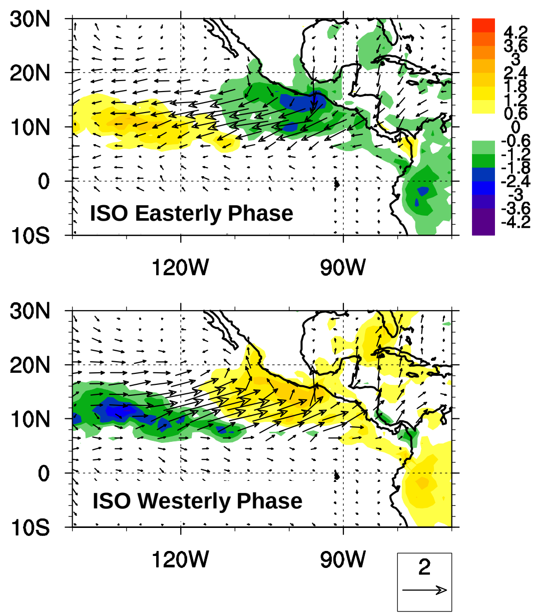

Figure 1. Regressed intraseasonal QuikSCAT vector wind and TRMM precipitation anomalies for surface easterly and westerly phases of the ISO. Precipitation shading is plotted in units of mm day^{-1} The reference wind vector with units of m s^{-1} is shown at the bottom right.

alies are generally associated with suppressed convection over the warm pool to the east of 120^{o}W (Figure 1b).

Anomalous ISO westerly flow is generally accompanied by enhanced wind speed to the east of 120^{o}W, while anomalous easterly flow is associated with suppressed wind speed. During the westerly phase, southwesterly intraseasonal vector wind anomalies combined with climatological southwesterly flow account for the bulk of the wind speed enhancement in the vicinity of 10^{o}N (Figure 2). Increased eddy activity on timescales of less than 20 days (including tropical cyclones and easterly waves) accounts for most of the wind speed increase just to the south of the Mexican and Central American coasts.

The increase in wind speed during periods of ISO westerly anomalies implies an increase in the wind-induced component of latent heat flux. TAO buoys along the 95^{o}W line, and the buoy at 8^{o}N, 110^{o}W, are used to examine the relationship between intraseasonal precipitation and latent heat flux. The buoys at 10^{o}N, 95^{o}W, and 12^{o}N, 95^{o}W were part of the enhanced monitoring phase

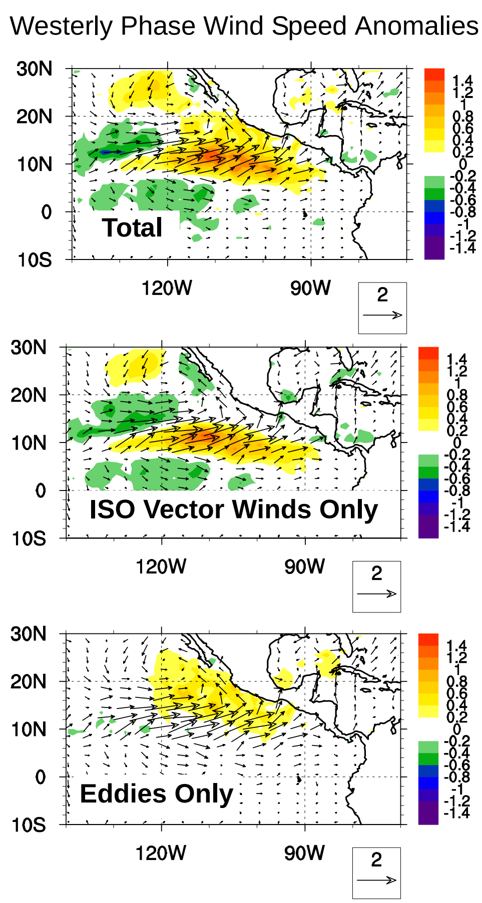

Figure 2. a) Composite intraseasonal wind speed anomaly at for ISO westerly phase reconstructed using intraseasonal vector wind and intraseasonal eddy wind speed variance anomalies. Intraseasonal vector wind anomalies are also shown. The eddy wind speed variance was constructed using wind components filtered to periods of less than 20 days. The wind speed anomaly that would be produced using only the intraseasonal vector wind anomalies is shown in b). The wind speed anomaly that would be produced using only the intraseasonal eddy wind speed variance anomalies is shown in c). Wind speed units are m s^{-1}. The reference wind vector with units of m s^{-1} is shown at the bottom right.

of EPIC2001. Buoy flux anomalies are primarily wind-induced. A statistically significant correlation of 0.59 between intraseasonal latent heat flux and precipitation occurs at the 12^{o}N, 95^{o}W buoy (Figure 3), consistent with previous studies suggesting a role for wind-evaporation feedback in supporting intraseasonal convection over the east Pacific warm pool. Blue dots show data during the field phase of EPIC2001. Correlations between precipitation and latent heat flux at the 10^{o}N, 95^{o}W and 8^{o}N, 95^{o}W buoys are positive, but not statistically significant, due to the short data record at these buoys. These diagnostics may provide potentially useful tests for climate model parameterizations of convection.

A negative, but not statistically significant correlation (-0.34) exists between intraseasonal precipitation and latent heat flux at the 8^{o}N, 110^{o}W buoy (Figure 3). Satellite observations show that the buoy is located in a region of suppressed convection during periods of enhanced wind speed, with anomalous frictional divergence and anomalously low column-integrated water vapor (SSM/I). In contrast, surface convergence and cyclonic vorticity anomalies occur over the warm pool to the north of 10^{o}N during convectively enhanced/westerly phases of the ISO.

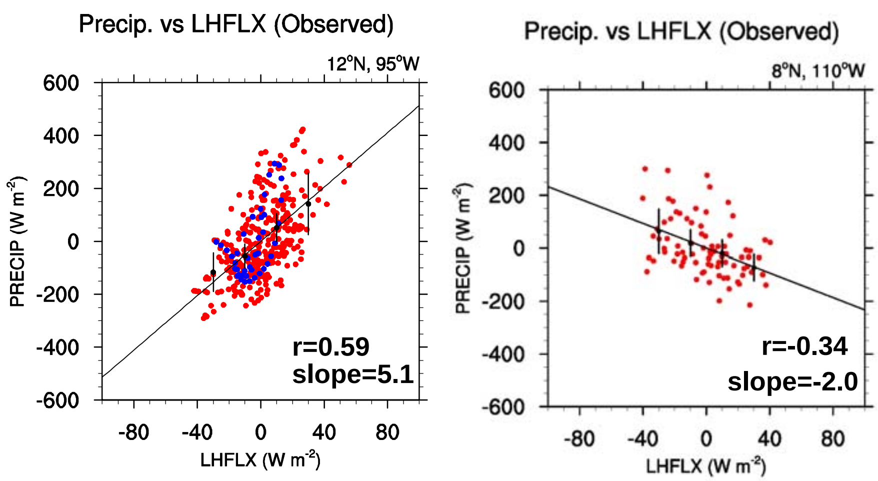

Figure 3. Scatterplot of 10-100 bandpass filtered TRMM precipitation vs. TAO buoy latent heat fluxes at a) 12^{o}N, 95^{o}W and b) 8^{o}N, 110^{o}W. The means of 20 W m^{-2} wide bins centered on -30 W m^{-2}, -10 W m^{-2}, +10 W m^{-2}, and +30 W m^{-2} are shown as black dots, along with the 90% confidence limits on this mean. Points during the field phase of EPIC2001 are shown in blue on the plot for 12^{o}N, 95^{o}W. The linear least squares fit to the data is shown, the slope of which is indicated on the bottom right. The correlation coefficient (r) is also indicated. Blue dots show data during the field phase of EPIC2001.

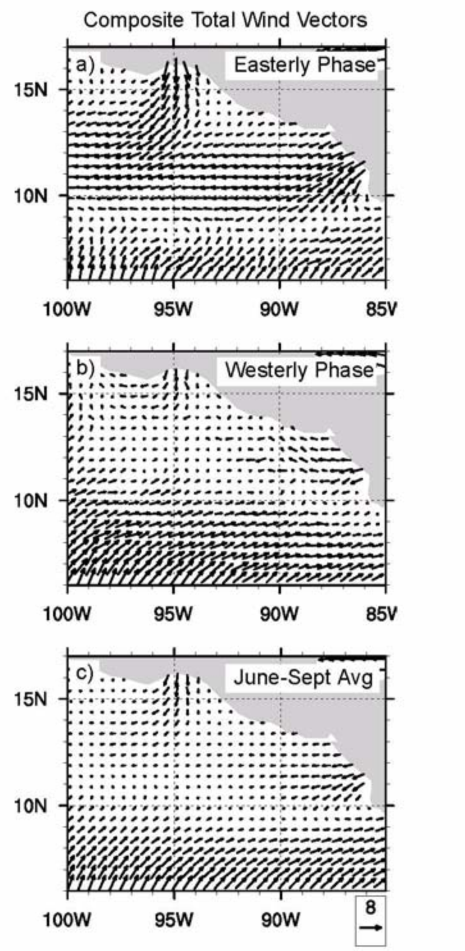

Figure 4. Composite unfiltered QuikSCAT westerly MJO events. June-September of 2000-2003 mean wind vectors are shown in c). The reference wind vector with units of m s^{-1} is shown at the bottom right.

Wind jets in the Gulf of Tehuantepec and Gulf of Papagayo appear to be active during periods of ISO easterlies and suppressed convection (Figure 4). These periods are characterized by enhanced trade winds across the east Pacific warm pool and Caribbean Sea, as well as anomalous surface anticyclonic vorticity over the Gulf of Mexico. The flow in the Gulf of Papagayo and Gulf of Tehuantepec during ISO westerly phases is close to that in the June-September mean.

c) Intraseasonal SST Variability and Regulation

We have analyzed the regulation of tropical eastern north Pacific sea surface temperatures by the summertime intraseasonal oscillation. Buoy and TRMM Microwave Imager SST products show a strong modulation of SST by the MJO over the east Pacific warm pool (Figure 5a). SST anomalies are in quadrature with precipitation, and are of sufficient magnitude to importantly influence ISO convection. Thus, ISO-induced SST variations may form a crucial component of North American monsoon system variability and the regulation of tropical cyclogenesis over the east Pacific and Gulf of Mexico (e.g. Maloney and Hartmann 2000a,b).

The processes responsible for this modulation of SST by the ISO are an area of ongoing exploration. A strong modulation of surface heat fluxes occurs over the east Pacific warm pool (Figure 5b), with shortwave and latent heat fluxes being the two dominant flux terms, and sensible heat and longwave radiation fluxes being considerably smaller. As was suggested by Maloney and Kiehl (2002), latent heat and shortwave fluxes may, to first order, regulate SST variability over the warm pool during an ISO lifecycle. Reduced surface shortwave radiation and increased latent heat fluxes are in phase with anomalous precipitation, thereby cooling the oceanic mixed layer. However, due to the shallow mixed layer depths in parts of the east Pacific warm pool, the upper ocean heat budget may be very sensitive to entrainment mixing and other ocean dynamical processes. Thus, how ocean dynamics influence the intraseasonal heat budget over the east Pacific is a key open question that we are presently examining. TAO buoy subsurface data is being used in conjunction with QuikSCAT surface stress to examine contribution of ocean dynamics to intraseasonal mixed layer heat budget variability.

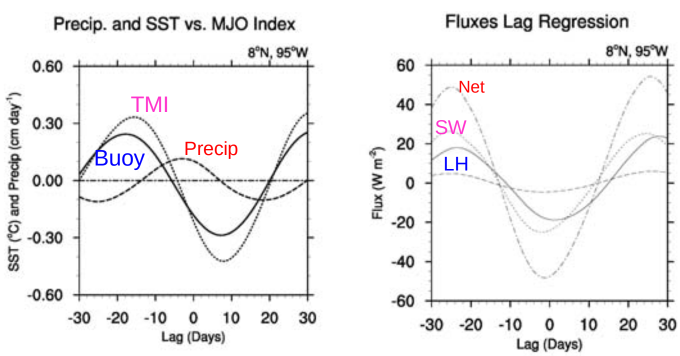

Figure 5. 8^{o}N, 95^{o}W a) SST from TMI and the TAO buoy and TRMM precipitation anomalies and b) TAO buoy surface flux anomalies (net, shortwave, and latent heat flux) during an ISO lifecycle. Positive fluxes are defined as a flux of heat into the ocean.

2. Year Two Plan

We intend to follow the Year 2 plan in our original proposal, which will form the majority of work during the next year. Since we have already gotten a head start on much of our Year 2 work (a good portion of which is contained in Maloney and Esbensen 2005), we will augment our original plan by exploring additional modeling strategies for understanding the oceanic mixed layer heat budget of the east Pacific warm pool. The group at IPRC at the University of Hawaii including Shang-Ping Xie, Simon de Szoeke, and Richard Small is using a regional coupled model over the east Pacific that appears ideal for explaining how ocean dynamics influence intraseasonal SST variability. We intend to contact them regarding possible collaborations. A simpler one-dimensional upper ocean model with entraining mixed layer will also be used to determine the role of variations in mixed layer to the upper ocean heat budget (such as used in Shinoda and Hendon 1998 and noted in our proposal).

The diagnostic shown in Figure 3 that describes the coupling between surface latent heat flux and tropical precipitation is a good measure against which to test climate model simulations of tropical precipitation, and may help us to improve such simulations. We have been doing some sensitivity tests with a climate model in which coupling between convection and surface forcing varies as a function of convection parameterization, and varies across a range of parameters within a given parameterization. Thus, we intend to further explore during Year 2 how well climate models represent convection-latent heat flux coupling, and whether we can improve model representations of convection through use of such diagnostics.

3. Budget

The budget has not changed from that originally described in the proposal.

4. References

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